United States
Department of
Agriculture

Forest Service

Northeastern Area

Administrative Report

82-2

Assessment of Tree Loss Due to Scleroderris Canker in the Lake States

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Introduction

From 1951 to 1963 severe, unexplained tree losses occurred in several red and jack pine plantations on the National Forests in the Lake States. In 1964 the losses were attributed to the fungus Gremmeniella abietina (Lagerberg) Morelet,[1/] then called Scleroderris lagerbergii. The following year, 1965, the Chequamegon and Nicolet National Forests in Wisconsin and the Hiawatha and Ottawa National Forests in Michigan were surveyed to determine the distribution of and damage due to Scleroderris canker. Of approximately 700 red and jack pine plantations 2 to 10 years old, 190 were examined and of these 128 were infected. The infected plantations were surveyed intensely, and total losses, including "missing" trees (empty planting spaces that were assumed once occupied by trees), were 40 percent (Skilling and Cordell 1966).

The 1965 survey did not reveal how large a portion of the tree mortality was caused by Scleroderris canker because the cause of death of the missing trees could not be determined. Because 80 percent of the losses were missing trees, our ability to evaluate the impact of Scleroderris canker was limited. To estimate how many missing trees were killed by the pathogen, 33 of the 1965 uninfected plantations that were comparable to infected ones were surveyed in 1977 to 1978. Also, to discern any increase in mortality 105 of the 1965 infected plantations were surveyed.

Survey Methods

In 1977 to 1978, two plots (20 trees each) per plantation were examined. This procedure yielded the same standard error of the mean number of trees lost per plot (.033) as that of the 1965 survey. The plots in infected plantations were selected at random from those established in the 1965 survey and relocated approximately. Because of a change in the numbering system used by the Forests, some plantations in the 1965 survey could not be located in 1977 to 1978, and others were substituted. In these, and in uninfected plantations, plots were selected at random from a list of all possible plots in each plantation.

Survey Results

The 1977 to 1978 survey results are compared with the 1965 results in Table 1. The data indicate a slight increase in losses since 1965, but the increase is not statistically significant. Scleroderris canker caused approximately one third of the losses on the Hiawatha National Forest (difference between infected and uninfected is significant at the 95 percent level of confidence) and one fourth of the losses on the Nicolet National Forest (90 percent level of confidence). Too few uninfected plantations were surveyed on the Ottawa and Chequamegon National Forests to compare with the infected plantations.

[1/]This report addresses damage caused by the North American strain only.

Table 1. Tree mortality in red and jack pine plantations on four National Forests in the Lake States from 1965 survey of plantations infected with Scleroderris canker and a 1977 to 1978 resurvey of infected uninfected plantations.

National Forest	1965 survey (Infected plantations only)				1977 to 1978 resurvey (Infected plantations)		1977 to 1978 resurvey (Uninfected plantations)	
	Number of plantations surveyed	Missing Trees	Dead or dying trees	Total mortality	Number of plantations surveyed	Mortality	Number of plantations surveyed	Mortality
	---------- Percent ----------					Percent		Percent
Hiawatha	40	32	9	41	45	45	14	30
Nicolet	30	29	10	39	24	35	14	25
Ottawa	24	30	11	41	18	45	4	62
Chequamegon	34	35	4	39	18	38	1	35
Total	128	32	8	40	105	41	33	32

Analyses

The effect of seedling losses on the eventual volume of a mature stand can be shown by comparing its expected volume with that of a stand with no seedling losses. Because the surviving trees in a stand "thinned" by tree mortality grow more rapidly than trees in a stand of normal stocking, the difference in volumes is not directly proportional to the percentage of losses. Thus, we must figuratively "grow" two stands, one with and one without tree mortality.

An added complexity is the behavior of Scleroderris canker which tends to kill trees in small groups or "pockets" rather than uniformly throughout a stand. The result is an "edge effect" on the growth of surviving trees. At the same time, the need for future thinnings of the portions of the stand with surviving trees is not removed by the tree mortality.

To represent the effects on growth of both mortality due to all causes and to the disease, the 362 plots on the Chequamegon National Forest (used as a sample) were stratified into three groups according to the losses per plot (Table 2). The results were applied to four of the National Forests in the Lake States.

Table 2. Stratification of sample 1965 survey plots on the Chequamegon National Forest according to loss.

Mortality group (Loss per plot)	Percent of plots	Average loss in trees per acre 1/
0 Trees	4	0
1-10 Trees	72	200
11-15 Trees	20	488
15-20 Trees	4	720

1/ Assumes planting at 800 trees per acre (1976 per hectare), an average in accord with planting records.

No trees were lost in 4 percent of the plots, so for the purposes of analysis, the acreages in the four National Forests with infected trees were reduced by 4 percent to 19,982 acres (8,093 ha) of red pine and 2,686 acres (1,088 ha) of jack pine.[2/]

Acreages were then weighted according to the number of infected trees found in each group (Table 3). No infected trees were found on the plots where no trees had been lost.

Effect of Red Pine Losses on Timber Volume (Sources: Benzie 1977b; Manthy, Rannard, and Rudolph, 1964)

Assumed: Typical plantation established in 1959; site index 60 (18 m in 50 yr); original planting of 800 trees per acre (1976/ha); stand to be thinned to 90 ft^2 basal area per acre (21 m^2/ha) at age 25 and at 10 year intervals thereafter, until rotation age 80.

A plantation of 800 trees per acre (1976/ha) would have a basal area of 138 sq ft^2 per acre (32 m^2/ha) at age 25 (Benzie 1977b, interpolations of Table 3). Such a stand would contain about 12.3 cunits (1 cunit = 100 ft^3) per acre (after applying correction factor for 4 inch top) or 86 m^3/ha (10 cm top) (Benzie 1977b, Table 5).

Table 3. Acreages of infected red and jack pine on four National Forests in the Lake States weighted according to infection in plots on Chequamegon National Forest.

Mortality group (Loss per plot)	Percent of all infected trees	Weighted Acres	
		Red Pine	Jack Pine
1 - 10 Trees	65	12,988	1,746
11 - 15 Trees	29	5,795	779
16 - 20 Trees	6	1,199	161
Totals	100	19,982	2,686

[2/]Estimates of acres planted are based on 1955-1963 planting records and the proportions with infected trees on the 1965 survey results.

The area in mortality group 1 (1 to 10 trees per plot) sustained losses of 200 trees per acre (494 trees/ha (Table 2) leaving 600 trees per acre (1,482 trees/ha). A 600 tree per acre stand contains 116 ft^2 basal area per acre (27 m^2/ha) at age 25 (Benzie 1977b, Table 3). The volume of such a stand (Benzie 1977b, Table 5) would be 9.5 cunits per acre (66 m^3/ha). Because the losses in infected plantations were 41 percent compared with 32 percent in uninfected plantations (Table 1), 9/41 of the loss is due to Scleroderris canker. The dollar loss is computed as follows: 12.3 cunits minus 9.5 cunits = 2.8 cunits x 9/41 x 12,988 acres x $20 per cunit (average 1979 selling price for cordwood) or approximately 19.6 m^3 x 9/41 x 5,260 ha x $7 per m^3 = $159,657. This sum discounted at 4 percent in 1980 is $136,475.

A stand with 116 ft^2 per acre basal area is probably not operable, and therefore the stand above would not be thinned at the expected age 25. An unthinned stand with 116 ft^2 of basal area at age 25 would contain 176 ft^2 per acre (40 m^2/ha) at age 35. In comparison, the undamaged stand thinned to 90 ft^2 at age 25 would contain only 150 ft^2 per acre (34 m^2/ha) at age 35. Thus, the loss is offset by 0.8 cunits per acre (5.6 m^2/ha) or a total of $207,808. When this is converted to the basis of losses due to Scleroderris canker (x 9/41), the value of losses must be reduced by $38,993 (present value).

The procedure to estimate loss in mortality group 1 is also used in mortality group 2 (loss of 11 to 15 trees per plot; 488 trees per acre) with one difference. Benzie does not provide basal areas for stands of fewer than 400 trees per acre. However, a smooth curve through his figures for 400, 800, and 1,200 trees per acre (interpolated for site index 60) will show that a stand with a stocking of 312 trees per acre (771/ha) has a basal area of about 80 ft^2 per acre (18 m^2/ha) at age 25. The loss sustained on the 5,795 acres (2,347 ha) in the group is $93,514 (present value).

A red pine stand with a basal area of 80 ft^2 per acre at 25 years would have a basal area of 136 ft^2 per acre (31 m^2/ha) at 35 years (based on Benzie, 1977 Table 4). In comparison, a fully stocked stand thinned to 90 ft^2 ver acre at age 25 would have a basal area of 150 ft^2 at age 35. Thus, at the time of the second thinning an additional loss of 2.3 cunits per acre (16 m^3) is sustained on the 7,194 acres in mortality group 2. The present value is $33,791.

The described procedure cannot be followed for mortality group 3 because we have no basal area estimates for 80 trees per acre. Benzie (1977b) states that 80 trees per acre is the minimum stocking for trees 15 inches (38 cm) in diameter and implies that red pine will reach 20 inches (51 cm) in 60 years only on the best sites. Presumably, the average tree will be about 18 inches (46 cm) dbh at the rotation age of 80. Thus, it seems reasonable to assume that the 80 trees per acre are sufficient

only for the final harvest and that the value of all thinnings and intermediate cuts is lost.[3/]

At $20 per cunit for cordwood ($7/m^3) stumpage and $48 per thousand board feet ($20/m^3) for sawlog stumpage (1979 average for the four Forests weighted according to acreage planted) the present value of all losses would be $517,706. The portion of the loss due to Scleroderris canker (x 9/41) would be $113,643. (Manthy, Rannard, and Rudolph 1964, Table 1).

The total losses due to Scleroderris canker in the red pine stands are 26,120 cunits (73,963 m^3) of cordwood and 3,580 Mbf (approximately 15,600 m^3) of sawtimber, together valued at $338,430.

Effect of Jack Pine Losses on Timber Volume (Source: Benzie, 1977a).

Assumed: Typical plantation established 1959; site index 50; original planting 800 trees per acre; rotation age 50 years with no intermediate thinning.

Using Benzie's (1977a) work on jack pine we followed a procedure similar to that followed for red pine to arrive at an estimate for jack pine losses. The total loss due to Scleroderris canker in the jack pine stands is 1,705 cunits of cordwood (4,828 m^3) valued at $10,936.

Discussion and Conclusions

We conclude that cost of damage from Scleroderris canker within red and jack pine plantations established from 1955 to 1963 on the four Forests could be as high as $400,000, but is probably less. In addition, about 1,000 acres (405 ha) of plantations on the Superior National Forest in Minnesota are infected, and perhaps 3,000 acres (1215 ha) on state and private land in the Lake States. The results of various surveys indicate that damage in these stands is comparable to the damage on the four Forests reported here. A survey in Michigan (Mosher et al 1979), revealed losses of about 32 percent on 1,600 acres (648 ha), of jack pine. If we assume yields and stumpages comparable to those on the four National Forests on a per-acre basis, the value of the losses on the Superior National Forest would be about $15,000, and overall state and private losses of red and jack pine in the Lake States would be $60,000 to 70,000.

Scleroderris canker has killed some trees in those National Forest plantations that were established after 1963, but the damage is probably minor. Once the cause of the disease was discovered and its potential for damage confirmed, steps were taken to ensure that only disease-free

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[3/]The argument that areas would be replanted when stocking had been reduced to a low level and that only replanting costs would be lost is not well supported. The 1977 to 1978 survey revealed little evidence of replanting on areas surveyed since 1965. Some plantations had been replanted before 1965, but this would not significantly affect the data presented here.

seedlings were planted. However, once the fungus develops on an area, the infestation usually remains entrenched due to nonlethal infections on plantation trees or on wild trees within or close to the plantation. As a result, some potential sites are now inhospitable to red or jack pine and must be planted, or naturally regenerated, in species that are resistant but less valuable. The productivity of the sites is therefore lowered. A 26,000 acre (10,530 ha) area of state land in Michigan was reported "lost to Scleroderris" and if it is to be regenerated it must be with resistant species. Another 15,000 acres (6,075 ha) of state land was converted to "other use" (presumably to use other than commercial forest) because of the disease (Anderson and Mosher 1976). However, the entire extent or cost of residual infestation has not been determined. We assume that our rough estimate would encompass the value of this particular impact, and we conclude that for the Lake States as a whole the value of the timber lost to Scleroderris canker is around $500,000.

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